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3,616,813

REGULATOR

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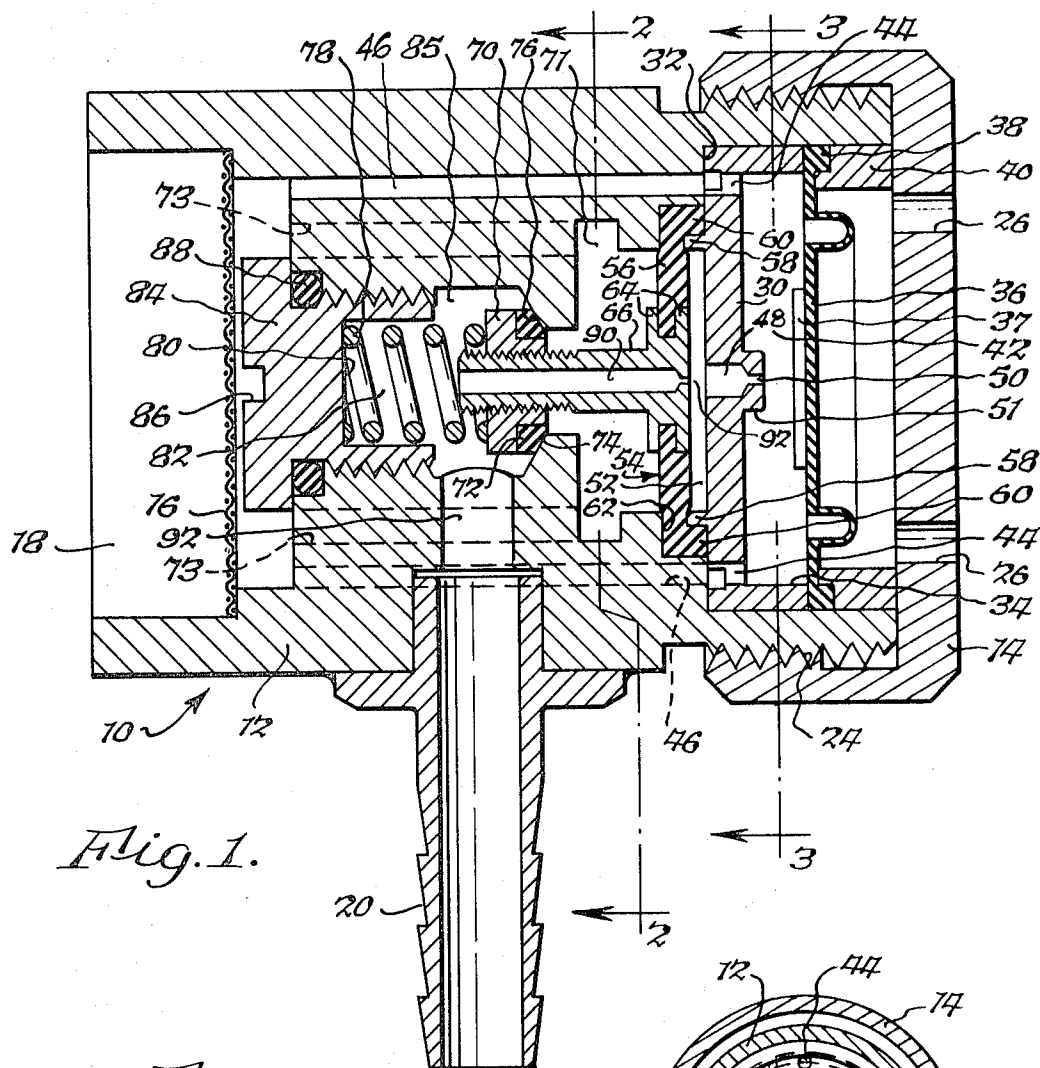


Fig. 1.

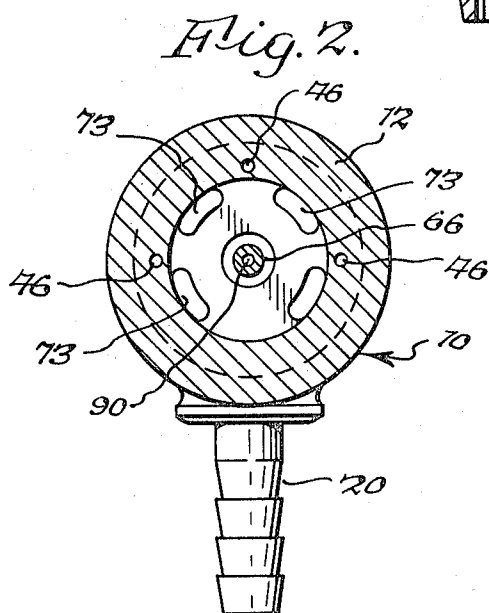


Fig. 2.

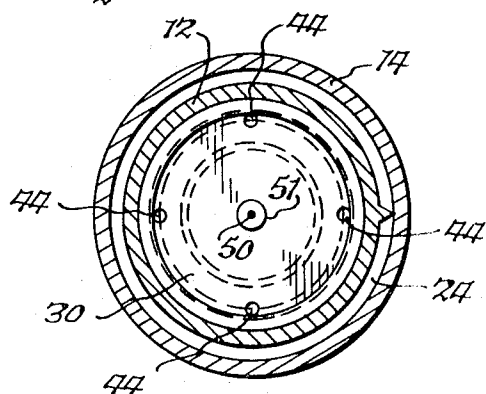


Fig. 3.

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1

3,616,813
REGULATOR

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10 Claims

ABSTRACT OF THE DISCLOSURE

A regulator comprising a body having a breathing fluid inlet passage and an outlet passage connected to the mask of a user with a control valve interposed between the inlet and outlet passage. A plate is mounted in the body and is provided with an orifice. A first diaphragm is mounted in the body on one side of the plate and a second diaphragm, operatively connected to a control valve, is mounted in the body on the other side of the plate. Upon inhalation, the first diaphragm is flexed to close the orifice, causing a build-up of pressure which acts on the second diaphragm to flex the same and open the control valve thereby establishing communication between the inlet and outlet passage. Upon exhalation, the orifice is opened to return the second diaphragm to its normal position, the control valve being carried by the second diaphragm into closing position.

BACKGROUND OF THE INVENTION

This invention relates to improvements in breathing apparatus and, more particularly, to a new and useful regulating valve for controlling the flow of breathing fluid in response to inhalation and exhalation by a user of the breathing apparatus.

Many designs for demand valves are known in which inhalation by the user of a breathing apparatus controls opening and closing of the main valve through a pilot valve. Such known valves customarily operate on the principle of utilizing the breathing fluid supply pressure for maintaining the main valve in a closed position and, upon inhalation causing a miniature or pilot valve to open thereby releasing pilot flow and consequently allowing the breathing fluid to flow from a supply line through the main valve to the mask. Generally, these known valves are relatively complex, bulky, and expensive to manufacture. Moreover, the release of pilot flow during inhalation tends toward flow instability and a proportional flow commensurate with actual demand is difficult to achieve.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to provide an improved regulator valve which is simple and strong in construction, rugged and durable in use, inexpensive to manufacture, and which possesses the requisite dynamic response and flow stability.

Another object of this invention is to provide a pilot operated regulator valve which is small and compact and can be readily incorporated in existing breathing apparatus used for commercial and medical purposes.

Generally speaking, the regulator valve of the present invention is characterized by the provision of a small, compact body incorporating an orifice therein which allows breathing fluid to pass to the mask during the expiratory phase or exhalation period. Inhalation causes the orifice to close, creating a build-up of pressure on a diaphragm which is flexed to unseat the main valve and establish communication between the breathing fluid inlet and the mask at a comparatively high flow rate. Exhalation causes the pilot orifice to be opened to permit a low flow rate to the mask and effect seating of the main valve to interrupt the high flow rate to the mask.

2

The foregoing and other objects, advantages and characterizing features of the present invention will become apparent from the ensuing detailed description of an illustrative embodiment thereof, taken together with the accompanying drawing wherein like reference numerals denote like parts throughout the various views.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a vertical, medial sectional view through a regulator valve of the present invention;

FIG. 2 is a transverse vertical sectional view, on a reduced scale, taken about on line 2—2 of FIG. 1; and

FIG. 3 is a transverse vertical sectional view, on a reduced scale, taken about on line 3—3 of FIG. 1.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

Referring now in detail to the drawing, there is shown in FIG. 1 a regulator of the present invention, generally designated 10, comprising a casing or body 12 having a closure cap 14 at one end thereof and a filter screen 16 at the other end suitably mounted in an outlet passage 18 leading to the mask of the user (not shown). Regulator 10 is employed to control passage of breathing fluid from a relatively high pressure supply line inlet fitting 20 through outlet 18 to the mask in response to inhalation by a user of the breathing apparatus.

Cap 14 is provided with an internally threaded portion 24 releasably threaded onto body 12. An annular plate member 30 is seated against an annular shoulder 32 in body 12 and is provided with an annular peripheral rim 34 projecting toward end cap 14 and bearing against one side of a flexible diaphragm 36 having a metal backing plate 37. A peripheral rim 38 is provided on the other side of diaphragm 36 and abuts against an annular, shouldered spacer 40, whereby diaphragm 36 is clamped in position between spacer 40 and rim 34 of plate 30 by cap 14. Diaphragm 36, plate 30 and rim 34 define a demand chamber 42 in regulator body 12, and plate 30 comprises a pilot valve seat as will become apparent. Cap 14 is provided with a plurality of openings 26 through its end wall placing the chamber on the side of diaphragm 36 opposite chamber 42 in communication with the ambient atmosphere.

A plurality of openings 44 are provided in plate 30 extending axially therethrough in registry with and corresponding in number to a plurality of elongated axial passages 46 leading to outlet passage 18 and filter screen 16. Although four openings 44 and four passages 46 are employed in the illustrated embodiment, any number of openings 44 and passages 46 can be provided within the purview of this invention. A cavity 48 is provided in plate 30 and communicates with an orifice 50 formed in a projection 51 of plate 30 and establishes communication between demand chamber 42 and a chamber 52 defined between plate 30 and a flow diaphragm 54, generally designated 54.

Flow diaphragm has a flat annular portion 56 spaced from plate 30 by means of annular projection 58 extending from one side of plate 30 and a peripheral rim portion 60 clamped between an annular shoulder 62 in body 12, projection 58 and said one side of plate 30. Diaphragm 54 is secured at its shouldered, annular recessed central portion between a pair of axially spaced flanges 64 extending radially outwardly from a valve stem 66 extending axially through body 12 and having a valve 70 threadedly mounted on the inner end of stem 66. A chamber 71 is defined within body 12 between valve 70 and diaphragm 54, and a plurality of passages 73 of generally arcuate cross-section extend axially of body 12 and establish communication between chamber 71 and outlet passage 18 leading to the mask.

3

Valve 70 is provided with a sealing ring 72 formed of an elastomeric material having a beveled seating surface 74 adapted to engage a beveled valve seat 76 projecting radially inwardly from body 12. A helical spring 78 is positioned between valve 70 and an abutment surface 80 provided at the bottom of a cavity 82 in an end cap member 84 threadably mounted in body 12 and spaced inwardly of filter screen 16. Spring 78 urges valve 70 against seat 76 to close communication between a pressure chamber 85 communicating with inlet 20 and chamber 71. Cap screw member 84 is slotted as shown at 86 to receive a screwdriver for threading member 84 in place. An O-ring seal 88 is disposed between an enlarged portion of member 84 and the internally threaded portion of body 12 to provide pressure sealing therebetween and prevent fluid leakage through cap screw member 84.

An axial passage 90 is provided in valve stem 66 and terminates in a restricted orifice 92 establishing communication between pressure chamber 85 and chamber 52. Body 12 is provided with a passage 94 leading to pressure chamber 85 and receiving inlet fitting 20 which latter is adapted to receive a conduit or hose connected to a suitable source of breathing fluid, such as a cylinder of oxygen (not shown) under pressure.

In use, valve 70 is normally urged against seat 76 by the action of spring 78. Breathing fluid under pressure is directed through inlet fitting 20 into pressure chamber 85 and through passage 90, orifice 92 and chamber 52. Breathing fluid also is admitted into demand chamber 42 from chamber 52 via cavity 48 and orifice 50 and flows to the mask of the user via openings 44, passages 46, passage 18 and through screen 16. Orifice 50, while larger in diameter than orifice 92, also is restricted and is considerably smaller in diameter than openings 44 and passages 46.

Thus an extremely small pilot flow of breathing fluid, as restricted by orifices 92 and 50, is admitted to the mask of the user during the period of exhalation. Since this pilot flow is extremely small, there is no serious loss of breathing fluid during exhalation, nor is there any impediment to normal breathing.

Upon inhalation, fluid is exhausted from chamber 42 much more rapidly than it can be replenished through orifices 92 and 50, whereby pressure in demand chamber 42 is reduced, resulting in a pressure differential causing diaphragm 36 to flex toward plate 30 until metal backing plate 37 abuts against projection 51 to seal orifice 50 and terminate pilot flow. Pressure fluid continues to be admitted into chamber 52 via passage 90 and orifice 92, and with orifice 50 closed the pressure in chamber 52 acting on diaphragm 54 builds up and produces a force greater than the combined forces of spring 78 and the fluid pressure in chamber 85 acting in the opposite direction on valve 70, whereupon the resulting pressure differential flexes diaphragm 54 away from plate 30, carrying with it stem 66 and consequently valve 70 to unseat the latter against the bias of spring 78. Breathing fluid under supply line pressure, thereupon is admitted to the mask via fitting 20, pressure chamber 85, around valve seat 74, chamber 71, passages 73, and passage 18 through filter screen 16.

It will be appreciated that because fluid under supply line pressure is continually admitted to chamber 52, diaphragm 54 moves to open valve 70 substantially immediately upon closing orifice 50, thereby providing a very rapid response to the user's demand.

Upon exhalation, exhaled fluid under pressure is admitted into demand chamber 42 through passages 46 and openings 44 causing diaphragm 36 to move to its normal position shown in FIG. 1, where a check valve prevents such reverse fluid flow into chamber 42, pilot flow through orifice 50 moves diaphragm 36 to the illustrated position when the pressure reducing effect of inhalation ceases.

4

In either case, pressure fluid in chamber 52 escapes through cavity 48 and orifice 50. The force of spring 78 and the fluid pressures acting against valve 70 and diaphragm 54 move the same toward plate 30 to seat valve 70 against valve seat 76. This cycle is repeated in response to inhalation and exhalation of the user, with extremely small pilot flow through orifice 50 continuing except during inhalation.

From the foregoing, it will be seen that the present invention provides an improved pilot operated regulator valve of a simple and compact design adapted for use in conventional breathing apparatus. By the provision of orifice 50, a constant flow of breathing fluid to the user's mask is provided except during inhalation, when a relative high flow rate of breathing fluid is admitted to the mask. As opposed to conventional regulator valves, pilot flow through orifice 50 occurs during exhalation and is terminated during inhalation to provide for a more stable flow of breathing fluid commensurate with actual demand. Since the flow through orifice 50 is extremely small, there is no serious loss of breathing fluid during exhalation, nor is there any impediment to normal breathing. The inhalation resistance is extremely low, and the regulator valve is capable of comparatively high flow rates.

A preferred embodiment of this invention having been disclosed in detail, it is to be understood that this has been done by way of illustration only.

I claim:

1. A breathing fluid regulator comprising: a body having a fluid inlet adapted to be connected to a source of breathing fluid under pressure and a fluid outlet passage; valve means for controlling the flow of breathing fluid from said fluid inlet to said fluid outlet passage; a chamber defining member mounted in said body and having an orifice therethrough; a first chamber in said body on one side of said member and a second chamber in said body on the other side of said member; means for admitting pressure fluid to said second chamber; means normally permitting communication between said first and second chambers through said orifice and responsive to a reduction in pressure in said first chamber below the pressure of the ambient atmosphere for closing said orifice and increasing the pressure in said second chamber; and means responsive to an increase of pressure in said second chamber for actuating said valve means to establish communication between said fluid inlet and said fluid outlet passage.

2. A breathing fluid regulator according to claim 1 wherein said means responsive to a reduction in pressure below the pressure of the ambient atmosphere includes a diaphragm mounted in said body on said one side of said member.

3. A breathing fluid regulator according to claim 2 wherein one side of said diaphragm is exposed to pressure fluid in said first chamber and the other side of said diaphragm is exposed to the ambient atmosphere.

4. A breathing fluid regulator according to claim 1 wherein said means responsive to an increase of pressure in said second chamber includes a diaphragm mounted in said body on said other side of said member.

5. A breathing fluid regulator according to claim 4 wherein said diaphragm is operatively connected to said valve means for moving the same between open and closed positions.

6. A breathing fluid regulator according to claim 5 wherein said valve means includes a stem connected to said diaphragm, a valve connected to said stem, and a valve seat formed in said body.

7. A breathing fluid regulator according to claim 6 wherein said stem includes a passage establishing communication between said fluid inlet and said second chamber.

5

8. A breathing fluid regulator according to claim 1 wherein said orifice establishes communication between said first and second chambers.

9. A breathing fluid regulator according to claim 8 wherein said first chamber is in communication with said fluid outlet passage and said second chamber is in communication with said fluid inlet.

10. A breathing fluid regulator according to claim 1 wherein said valve means includes a stem connected at one end thereof to the last mentioned responsive means, a valve connected to the other end of said stem, and a valve seat formed in said body.

5

10

6

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